RECORDING MEDIUM HAVING DATA STRUCTURE FOR MANAGING REPRODUCTION OF AT LEAST VIDEO DATA REPRESENTING MULTIPLE REPRODUCTION PATHS AND RECORDING AND REPRODUCING METHODS AND APPARATUSES

RELATED APPLICATION DATA

[0001]   This is a continuation of Application No. 10/176,367 filed June 20, 2002; the contents of which is hereby incorporated by reference in its entirety.

BACKGROUND OF THE INVENTION

Field of the Invention

[0002]   The present invention relates to a recording medium having a data structure for managing reproduction of at least video data representing multiple reproduction paths as well as methods and apparatuses for reproduction and recording.

Description of the Related Art

[0003]   Owing to technical improvement in the fields of video/audio data compression, digital modulation/demodulation, and so on, a digital television broadcast system broadcasting TV signals in the form of digital data stream is being standardized rapidly.

[0004]   In the digital television broadcast system, audio/video (A/V) signals to be broadcasted are compressed according to the data

compressing rule specified by MPEG 2 (Moving Picture Experts Group) and the compressed A/V data are broadcasted in the form of transport stream (TS), which is also defined in MPEG 2 standard, composed of successive 188-byte-long transport packets (TPs).

[0005]   The digital TV broadcast system, which will be commercialized soon owing to technical improvement of A/V data compression and transmission, is able to support much higher-quality of video and audio than an analog TV system. Furthermore, it ensures data compatibility with a digital communication device, a digital storage device, etc.

[0006]   In the meantime, a new device is being developed to prepare for commercialization of digital TV broadcast system. That is a digital recorder being able to receive TS of digital broadcast programs and to record it on a writable HD-DVD. Such a digital recorder will be widely used as the digital TV broadcast system is commercialized in earnest.

[0007]   A single physical broadcast channel (called 'RF channel' in general) has about 6MHz bandwidth which ensures 19.4Mbps data rate. This data rate can carry a single HD-TV broadcast signal or about four SD-TV signals. Such a logical or virtual channel carrying one SD-TV signal in an RF channel is called 'digital channel'.

[0008]   In other words, a single RF channel sometimes includes several digital channels, namely, sub-channels which carry mutually-different broadcast programs.

[0009]   Therefore, a DVD recorder being developed may have to record two or more digital channels simultaneously at a user's request.

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However, if a DVD recorder records a plurality of digital channels and creates management information through the same manner as it does for a single digital channel, a DVD could not tell digital channels apart among a recorded stream of digital channels. Namely, a user could not select only one program, i.e., one digital channel to be reproduced among the recorded plurality of digital channels.

SUMMARY OF THE INVENTION

[0010]   The recording medium according to the present invention includes a data structure for managing the reproduction of at least video data representing multiple reproduction paths.

[0011]   In one exemplary embodiment, a data area of the recording medium stores a transport stream of at least video data. The transport stream is divided into transport packets. Each of the transport packets is associated with one of the multiple reproduction paths, and the transport packets of each reproduction path are interleaved with one another.

[0012]   In one embodiment, the transport packets associated with each reproduction path may be grouped into data blocks, and the transport packets of each reproduction path are interleaved with one another on a data block by data block basis. For example, each data block may represent at least an intra-coded picture of video data. As another example, each data block represents at least one group of pictures (GOP).

[0013]   In another embodiment, the recording medium also includes a navigation area storing navigation information. The navigation

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information includes a map associated with each file, and each map provides position data for the video data of the associated file.

[0014]   The navigation area may also include a navigation data item. The navigation data item provides navigation information for reproducing each of the files. The navigation data item may also include a multiple reproduction path indicator indicating that the navigation data item provides navigation information for multiple reproduction paths.

[0015]   The present invention further provides apparatuses and methods for recording and reproducing the data structure according to the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016]   The accompanying drawings, which are included to provide a further understanding of the present invention, illustrate the example embodiments of the invention, and together with the description, serve to explain the principles of the present invention, and wherein:

[0017]   Fig. 1 is a block diagram of an apparatus recording a multi-channel stream in accordance with the present invention;

[0018]   Fig. 2 illustrates a series of transport packets belonging to two sub-channels outputted in the form of single stream or mutually-separated streams;

[0019]   Fig. 3 illustrates the first embodiment of creating navigation data for substreams of a plurality of digital channels recorded in a

single high-density stream object unit (abbreviated to 'HOB' hereinafter) in accordance with the present invention;

[0020] Figs. 4 to 7 are illustrative structures of navigation data created when a multi-channel stream is recorded as shown in Fig. 3;

[0021] Fig. 8 illustrates the second embodiment of creating navigation data for substreams of a plurality of digital channels recorded in a single HOB in accordance with the present invention;

[0022] Fig. 9 illustrates the third embodiment of creating navigation data for substreams of a plurality of digital channels recorded in a single HOB in accordance with the present invention;

[0023] Fig. 10 illustrates the fourth embodiment of creating navigation data for substreams of a plurality of digital channels recorded in a single HOB in accordance with the present invention;

[0024] Fig. 11 illustrates the fifth embodiment of creating navigation data for substreams of a plurality of digital channels recorded in a single HOB in accordance with the present invention;

[0025] Fig. 12 illustrates the sixth embodiment of creating navigation data for substreams of a plurality of digital channels recorded in a single HOB in accordance with the present invention; and

[0026] Fig. 13 illustrates the seventh embodiment of creating navigation data for substreams of a plurality of digital channels recorded in a single HOB in accordance with the present invention.

DETAILED DESCRIPTION OF THE EXEMPLARY EMBODIMENTS

[0027]   In order that the invention may be fully understood, an example embodiment thereof will now be described with reference to the accompanying drawings.

[0028]   Fig. 1 is a block diagram of an apparatus recording a multi-channel stream in accordance with the present invention.

[0029]   The apparatus of Fig. 1 may be a digital video recorder (DVR) being able to record a digital broadcast signal on a recording medium, e.g., a writable HD-DVD. The apparatus comprises a tuner 10 tuning its passband to at least one RF band of digital broadcast TV signal; a stream selector 11 selecting a plurality of substreams belonging to chosen digital channels (or sub-channels) from a data stream of an RF channel or channels passed by the tuner 10; a recording processor 12 recording the selected substreams in a single HOB (High-Density Stream Object) or HOBs according to a preset recording mode, creating and writing navigation data every a recorded substream; an optical pickup 13 forming mark/space patterns on a HD-DVD 100 in accordance with bit patterns of stream and navigation data outputted from the recording processor 12; and a controller 14 conducting overall control operations of all elements for multi-stream record.

[0030]   The tuner 10 passes one digital broadcast TV channel, namely, an RF channel selected by the controller 14. The stream selector 11 extracts transport packets (TPs) belonging to several, e.g., 2 digital channels selected through the controller 14 from a multi-channel stream of the RF channel passed by the tuner 10. The extracted series of TPs by the stream

selector 11 is outputted in the form of single stream 201 or mutually-separated streams 202_1 and 202_2, as illustrated in Fig. 2.

[0031]   The tuner 10 can also pass multiple RF channels. In multiple passing mode, the stream selector 11 is also able to extract more than one substream from each RF channel to output a series of TPs belonging to digital channels chosen from available channels offered by respective RF channels.

[0032]   For the convenience of explanation, it is supposed in all embodiments described in below that the stream selector 11 selects two substreams, namely, two digital channels from a received multi-channel stream.

[0033]   The recording processor 12 can distinguish two digital-channel substreams, namely, the first and the second substream each other based on packet ID (PID) written in every TP outputted from the stream selector 11.

[0034]   The first and the second digital-channel substream are recorded according to a preset recording mode. If the preset recording mode is 'mixed/grouping', the recording processor 12 records two multiplexed substreams from the stream selector 12 in a single allocated HOB 301 while grouping every some TPs for each substream and arranging grouped units of different channels sequentially, as shown in Fig. 3.

[0035]   The TP-grouped unit interleaved one after another channel is a random accessible GOP (Group of Pictures) unit defined in MPEG standard or a data block of which size is equal to storage capacity of a HOB unit (HOBU)

constituting a HOB. Since a GOP consists of full pictures only, pictures are not broken even if data is reproduced from its start point, therefore, every GOP ensures random accessibility.

[0036]   In the meantime, the recording processor 12 creates navigation data for each digital-channel substream based on the distinguished digital-channel information and each substream recording information. The way how navigation data is created is described below in detail.

[0037]   Fig. 3 illustrates the first embodiment of creating navigation data for substreams of a plurality of digital channels recorded in a single HOB while every some TPs are grouped for each channel in accordance with the present invention.

[0038]   A recording medium for recording a digital broadcast signal has a provisional recording standard. According to the provisional recording standard, a recording medium shall have Program Chain Information (PGCI) prepared for index of every recorded program and for reproduction order among them. The PGCI includes Program Information (PGI) and Cell Information (CI) which are respectively created for each single data stream continuously recorded from recording start to stop. Furthermore, a single Presentation Time Map (PTMAP) shall be created for each single recorded data stream according to the provisional recording standard. The PTMAP, used for stream search, has collection of position data or position-related time length data for every data unit constituting a recorded data stream. Search pointer and information of each PTMAP are included in HOB information (HOBI).

[0039]   However, for two substreams recorded in a single HOB

while every some TPs or every TPs constituting a GOP are grouped in accordance with the first embodiment of the present invention, not single but two pieces of CI 'Cell #1 and Cell #2' and not single but two pieces of PTMAPI for two PTMAPs are created respectively, and a single piece of PGI 'PGI #1' is created, as shown in Fig. 3. Consequently, plural pieces of CI, namely, two pieces of CI are associated with single piece of PGI in this embodiment, which means that single piece of CI includes information on only one substream of a single digital channel.

[0040]   The PGI and the CI are written in the PGCI while the PTMAP and the PTMAPI are in the HOBI.

[0041]   In general, navigation data such as PGCI and HOBI is loaded into a memory (not figured) from the HD-DVD 100 during recording mode, and the pieces of PGI, CI and HOBI created as above are inserted in the navigation data which will be stored in a navigation data area of the HD-DVD 100 after the substreams of plural digital channels are completely recorded.

[0042]   Figs. 4 to 7 are illustrative structures of navigation data created when a multi-channel stream is recorded as shown in Fig. 3.

The PGCI of Fig. 4 includes program chain general information 'PGC_GI', plural pieces of PGI 'PGI #1 to #n', a plurality of CI search pointers 'CI_SRP #1 to #m', and plural pieces of CI 'CI #1 to #m'. Each piece of PGI includes fields of program type 'PG_TY' and the number of CI 'C_Ns'.

[0043]   The program type 'PG_TY', 8-bit long, is composed of 'Protect' flag, 'S/M' flag, 3-bit number of channels 'Channel_Ns' and RF channel number 'R_CH_N' as shown in Fig. 5. The 'Protect' flag indicates

whether an associated program (PG), equivalent to a conceptually-unitized stream, is erasable or not. The 'S/M' indicates whether an associated PG includes a single-channel or a multi-channel stream, and the number of channels 'Channel_Ns' describes the number of digital channels included in a recorded stream of an associated PG. The sub-field 'R_CH_N' describes RF channel number of a recorded stream of an associated PG.

[0044] For example, for the HOB #1 of Fig. 3 in which two substreams of two digital channels are recorded, '010' (=2) is written in the field 'Channel_Ns' allocated in the program type 'PG_TY' of the first piece of PGI 'PGI #1' and the 'S/M' flag allocated in the program type 'PG_TY' is set to represent multi-channel stream. Furthermore, because a piece of CI is created for each digital channel, '2' is written in the field 'C_Ns' of the first piece of PGI 'PGI #1' for the recording example of Fig. 3.

[0045] Each piece of CI is, as shown in Fig. 4, composed of five fields of cell type 'C_TY', HOBI search pointer number 'HOBI_SRPN', PTMAP number 'PTMAPN', start PTM of a cell 'C_V_S_PTM', and end PTM of a cell 'C_V_E_PTM'.

[0046] The field 'C_TY', 8-bit long, is composed of sub-fields of 2-bit cell type 'C_TY1', 3-bit channel number of a cell 'C_CH_N', and reserved as shown in Fig. 6 where the sub-field 'C_TY1' indicates whether a cell is related with multi-channel or single-channel stream, and the sub-field 'C_CH_N' describes digital channel number of a recorded substream referred by a cell.

[0047] For example, digital channel numbers of the first and the

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second substream are respectively written in those sub-fields 'C_CH_N' of the two pieces of CI 'CIs #1 and #2' referring to the HOB #1 of Fig. 3 in which two substreams of two digital channels are included.

[0048]   The HOBI, linked with the CI through the field 'HOBI_SRPN' included in each piece of CI, comprises HOBI general information 'HOBI_GI', a plurality of PTMAP search pointers 'PTMAP_SRP #1 to #n', and plural pieces of PTMAP information 'PTMAPI #1 to #n', as shown in Fig. 7.

[0049]   The HOBI general information 'HOBI_GI' consists of many fields of HOB type 'HOB_TY', HOB recording time 'HOB_REC_TM', start PTM of a HOB, end PTM of a HOB, the number of PTMAPs 'PTMAP_Ns', and start addresses of all PTMAPs 'PTMAP_SA #i'.

[0050]   The PTMAPI includes PTMAP general information 'PTMAP_GI' and entries of random accessible HOB units 'HOBU_ENT #1 to #j'. The PTMAP general information 'PTMAP_GI' is composed of fields of video 'V_PID' and audio packet ID 'A_PID', indicative of respective PIDs of audio and video TPs constituting a recorded stream associated with a PTMAP, HOBI index number 'HOBI_STIN', the number of random accessible HOB units 'HOBU_ENT_Ns', start PTM of a PTMAP 'PTMAP_S_PTM', and end PTM of a PTMAP 'PTMAP_E_PTM'.

[0051]   The navigation data structured as shown in Figs. 4 to 7 is created and recorded for a recorded multi-channel stream, as a result, when a HOB is chosen to be reproduced it can be known that the chosen HOB contains substreams of a plurality of digital channels based on the program type 'PG_TY' and the number of CI 'C_Ns' in a piece of PGI, included in the

PGCI, associated with the chosen HOB.

[0052]   Each digital channel number can be known from a piece of CI of which index number is equal to that of the PGI.

[0053]   When searching a substream of a chosen digital channel contained in a recorded multi-channel stream in a HOB, a PTMAP associated with a substream of the chosen digital channel is determined first based on the information written in the number of PTMAPs 'PTMAP_Ns', each PTMAP start address 'PTMAP_SA #i', and start and end PTM of a PTMAP 'PTMAP_S_PTM' and 'PTMAP_E_PTM' of the PTMAP general information 'PTMAP_GI' of each piece of PTMAP information 'PTMAPI #i'. Next, a substream of the chosen digital channel is searched and then reproduced selectively among a recorded multi-channel stream using PTM incremental time and size of each data unit written in the determined PTMAP.

[0054]   Fig. 8 illustrates the second embodiment of creating navigation data for substreams of a plurality of digital channels recorded in a single HOB while every some TPs are grouped for each channel in accordance with the present invention.

[0055]   This second embodiment of Fig. 8 is different from the first of Fig. 3 in that a single piece of CI is created. However, the PTMAPI used for substream-distinguishable searching is created the same as the first embodiment, namely, as many pieces of PTMAPI as the number of digital channels contained in a multi-channel stream are created.

[0056]   Since this second embodiment is different from the first in the number of pieces of CI created after block-interleaving record of

substreams, the structure of the CI is a little changed from Fig. 4.

[0057]   A piece of CI of this second embodiment includes a 'field of the number of channels' besides the fields of Fig. 4, and the field group composed of the PTMAP number 'PTMAPN', start PTM of a cell 'C_V_S_PTM', and end PTM of a cell 'C_V_E_PTM' is created as many as the number of digital channels contained in a recorded stream referred by the piece of CI. In addition, an additional field for writing digital channel numbers is reserved in the piece of CI since a single piece of CI covers all of digital channels contained in a recorded multi-channel stream. An additional field for writing digital channel numbers may be allocated in the PGI.

[0058]   Since the CI has information on the number of channels of a recorded stream, the PGI need not have that information. Accordingly, in this second embodiment, the 3-bit sub-field 'Channel_Ns' of Fig. 5 allocated in the program type 'PG_TY' is removed from the PGI.

[0059]   In addition, because a single piece of CI is created even though a stream of a plurality of digital channels is recorded, the field 'C_Ns' indicative of the number of pieces of CI is removed from the PGI of Fig. 4.

[0060]   Even in this second embodiment, all information on every recorded substream of every digital channel is included in navigation data the same as in the first embodiment. Therefore, a substream of a selected digital channel only can be searched and reproduced among mixed multiple substreams.

[0061]   Fig. 9 illustrates the third embodiment of creating navigation data for substreams of a plurality of digital channels recorded in a

single HOB while every some TPs are grouped for each channel in accordance with the present invention.

[0062]   This third embodiment of Fig. 9 creates and records as many pieces of PGI as the number of digital channels, besides CI and PTMAPI.

[0063]   Therefore, in this third embodiment, a piece of PGI covers only single substream contained in a multi-channel stream. In this case, since a piece of PGI shall accompany at least one piece of CI a piece of CI need not reserve a field for information about a plurality of digital channels. Therefore, the sub-fields of Fig. 6, namely, the cell type 'C_TY1' allocated for identifying 'multi' or 'single' stream need not be assigned in a piece of CI. Furthermore, the PTMAP number field 'PTMAPN' is removed from CI fields.

[0064]   In addition, since a piece of PGI is created for each substream, a piece of PGI need not manage plural channels, so that the sub-field 'Channel_Ns' allocated in the program type 'PG_TY' of Fig. 5 is not necessary. Instead, a new field for writing channel number of an associated substream shall be allocated in the PGI. If the new field is allocated in the PGI, the sub-field 'C_CH_N' in the cell type 'C_TY' can be removed from the CI associated with the PGI.

[0065]   Fig. 10 illustrates the fourth embodiment of creating navigation data for substreams of a plurality of digital channels recorded in a single HOB in accordance with the present invention.

This fourth embodiment of Fig. 10 is different from the first of Fig. 3 in that PTMAPI 1001 for a multi-channel stream is further created besides respective PTMAPI for each substream.

[0066] Since there are two types of PTMAPI for a single substream and entire substreams multiplexed in a multi-channel stream it is necessary to distinguish types. Thus, an additional PTMAP type field for distinguishing types, namely, 'single' and 'mixed' shall be allocated in the PTMAP general information 'PTMAP_GI' in Fig. 7. The same as PTMAPI, the CI shall be distinguished by the type of a referred stream, namely, 'single' for a single substream and 'mixed' for entire substreams, so that an additional field for writing 'single' or 'mixed' is needed in the CI. However, instead of allocating the additional field, the cell type 'C_TY1' of Fig. 6 may be used for this type discrimination by respective new codes assigned to 'single' and 'mixed'.

[0067] The PTMAP for a multi-channel stream may not be created in stream recording. Instead, it is constructed from PTMAPs of respective substreams when it is necessary.

[0068] In this fourth embodiment of Fig. 10, three pieces of CI are created even though two substreams are recorded. As a result, for the illustrative multi-channel stream record of Fig. 10, '3' (=the number of channels +1) is written in the field 'C_Ns' of a piece of PGI and the number (=2) of actual channels is written in the sub-field 'Channel_Ns' in the program type 'PG_TY'.

[0069] In addition, special code, e.g., zero (=0), which is not used as an actual channel number, is written in the channel number sub-field 'C_CH_N' of the CI referring to a multi-channel stream. The object of using such a special code is to identify easily which navigation data is associated with an entire multi-stream in case that a channel number can not be assigned

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when a multi-channel stream is to be searched or reproduced not selectively but overall as it is recorded.

[0070] Fig. 11 illustrates the fifth embodiment of creating navigation data for substreams of a plurality of digital channels recorded in a single HOB in accordance with the present invention.

[0071] This fifth embodiment of Fig. 11 is different from the second of Fig. 8 in that PTMAPI 1001 for a multi-channel stream is further created besides respective PTMAPI for each substream.

[0072] The same as the fourth embodiment, this fifth embodiment includes an additional PTMAP type field for 'single' and 'mixed' in the PTMAP general information 'PTMAP_GI' in Fig. 7.

[0073] The PTMAP for a multi-channel stream may not be created in stream recording. Instead, it is constructed from PTMAPs of respective substreams when it is necessary.

[0074] This fifth embodiment of Fig. 11, similar to the second embodiment, has an additional field for writing the number of virtual channels, in which 'the number of actual digital channels'+1 is written, in the CI besides the fields of Fig. 4. And it has also as many field groups as the number of digital channels plus 1 in the CI. A field group is composed of the PTMAP number 'PTMAPN', start PTM of a cell 'C_V_S_PTM', and end PTM of a cell 'C_V_E_PTM'.

[0075] In addition, a new field for writing 'single' or 'mixed' is created for each field group in the CI to indicate whether a field group is related with a single or a multi-channel stream. And, another new field for writing

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channel number of a related substream or multi-channel stream is also allocated for each field group because a single piece of CI manages a plurality of substreams.

[0076]   A special code, e.g., zero (=0) is written in the new channel number field of a field group assigned to a multi-channel stream to achieve the same object with the fourth embodiment.

[0077]   Fig. 12 illustrates the sixth embodiment of creating navigation data for substreams of a plurality of digital channels recorded in a single HOB in accordance with the present invention.

[0078]   This sixth embodiment of Fig. 12 is different from the third of Fig. 9 in that PTMAPI 1001 for a multi-channel stream is further created besides respective PTMAPI for each substream.

[0079]   The same as the fourth embodiment, this sixth embodiment includes an additional PTMAP type field for 'single' and 'mixed' in the PTMAP general information 'PTMAP_GI' in Fig. 7. The same as PTMAPI, the CI shall be distinguished by the type of a referred stream, namely, 'single' for a single substream and 'mixed' for entire substreams, so that an additional field for writing 'single' or 'mixed' is needed in the CI. However, instead of allocating the additional field, the cell type 'C_TY1' of Fig. 6 may be used for this type discrimination by respective new codes assigned to 'single' and 'mixed'.

[0080]   Since a piece of PGI is created even for a multi-channel stream in this sixth embodiment, a piece of PGI must have an additional field for PGI type, namely, 'single' or 'mixed' or have respective codes for 'single' or 'mixed'.

[0081]   The PTMAP for a multi-channel stream may not be created in stream recording. Instead, it is constructed from PTMAPs of respective substreams when it is necessary.

[0082]   This sixth embodiment creates a piece of PGI for each substream the same as the third embodiment, so that the CI need not have information for a plurality of channels. Consequently, the channel number 'C_CH_N' is not necessary, and the PTMAP number 'PTMAPN' is not necessarily assigned in the CI, either.

[0083]   Furthermore, since there is no need that a piece of PGI manages a plurality of channels, the sub-field 'Channel_Ns' in the program type 'PG_TY' of Fig. 5 is not necessary. Instead, an additional field for writing channel number of a related stream shall be allocated in the PGI.

[0084]   A special code, e.g., '0' is written in this channel number field allocated newly in the PGI associated with a multi-channel stream.

[0085]   Fig. 13 illustrates the seventh embodiment of creating navigation data for substreams of a plurality of digital channels recorded in a single HOB while every some TPs or every TPs constituting a GOP are grouped for each channel in accordance with the present invention.

[0086]   This seventh embodiment of Fig. 13 is different from the first of Fig. 3 in that a single piece of PTMAP and PTMAPI is created, respectively even though plural pieces of CI are created for a multi-channel stream.

[0087]   Since this seventh embodiment creates a single piece of PTMAP and PTMAPI after block-interleaving record of plural substreams, each

entry of the PTMAP has an additional field to indicate which channel of substream its incremental time length and size belong to. In this additional field, the channel number of a corresponding substream is written.

[0088] In addition, the PTMAPI has an additional field to identify whether an associated PTMAP includes such search information for a single or multi-channel stream.

[0089] All pieces of CI created for multiple substreams refer to the single identical PTMAP, namely, Same number is written in the field 'PTMAPN' of all pieces of CI created respectively for multiple substreams.

[0090] The above-explained multi-channel stream recording method and apparatus make it possible to selectively search and reproduce each substream among a multi-channel stream recorded on a recording medium, thereby improving use convenience of a recording machine such as a digital video recorder.

[0091] It will be apparent to those skilled in the art that various modifications and variations can be made in the present invention without departing from the spirit or scope of the invention. Thus, it is intended that the present invention cover the modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents.